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RECORDS AND DESCRIPTIONS OF AMERICAN MEGACHILID BEES (Hymenoptera)

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Within the past twenty-two years all of the non-parasitic genera of Megachilidae occurring in North America have received revisional treatment. In order to bring together a list of these revisions, they are all cited in the terminal bibliography. A few additional species have been described, but since they will be included in a forthcoming catalogue of North American Hymenoptera, it seems unnecessary to give them detailed consideration here.

The following new records and new species are of interest principally in connection with the appropriate revisions.

Heteranthidium cordaticeps n. sp.

Anthidium zebratum, Howard, 1901, Insect Book, pl. 4, fig. 33 (misidentification).

The bee figured by Howard is not **H. zebratum** (Cresson) but a very distinctive new species, recognizable by the reddish brown coloration and particulary by the broad deep median indentation in the vertex, especially posteriorly, so that the head is somewhat heartshaped. In Schwarz's key (1926) this species runs to 6 and is probably closest to **H. fontemvitae** Schwarz from Florida, but differs by the above mentioned characters, among others.

Female: 13.5 mm. Robust, body shaped as in **H. fontemvitae.** Mandibles tridentate, the margin less oblique than in **fontemvitae;** head broader than long; inner margins of eyes slightly converging below; clypeus and lower portions of paraocular areas shining, rather coarsely punctate, the punctures well separated; punctation of rest of head finer and closer; anterior margin of clypeus denticulate with about six denticles, a noticeable emargination between the inner pair; genal areas markedly broader than eyes seen from side; vertex broad, distance between posterior ocelli about half distance from one of them to posterior margin of vertex; vertex with broad median depression, becoming broader and deeper to rear where it merges with the occipital region. Mesoscutum and mesoscutellum dull, finely and very densely punctate, more finely so than vertex; mesepisterna more coarsely but closely punctate; posterior lobe of pronotum with strong carina; inner hind tibial spur slightly bent subapically. Abdomen rather dull and rather closely punctate as in **fontemvitae,** posterior margins of the terga thin, slightly curved upward, terga not emarginate or otherwise modified as in **ridingsii** (Cresson).

Ground color reddish brown; apices of mandibles, upper surfaces of antennal flagella, large spot above the base of each antenna, sides of pronotum, a longitudinal median band (widest anteriorly) on mesoscutum,

lower portions of mesepisterna, upper portions of metepisterna, propodeal triangle, and extreme bases of abdominal terga black or nearly so; paraocular areas, especially near the eyes, and abdominal bands dull pale yellow; abdominal bands broad laterally, gradually narrowed medially as usual in the genus on first to third metasomal terga,[1] only slightly narrowed medially on remaining terga which are therefore almost wholly yellow; yellow areas ill-defined, more or less fading into reddish brown background; clypeus, posterior lobes of pronotum, and tarsi more yellowish than remainder of ground color. Wings light brown.

Holotype female and one female paratype: Texas, without definite locality, from Belfrage collection. One female paratype: Austin, Texas (A. L. Melander). The holotype and one paratype are in the United States National Museum; one paratype is in the Snow Entomological Collections.

Anthidium (Melanthidium) rodriguezi Cockerell

Described from Guatemala and subsequently redescribed as **Melanthidium carri** Cockerell from Honduras. A male from Cuernavaca, Morelos, Mexico, October, 1944 (N. L. H. Krauss) agrees with the type except for larger size (length 20 mm.).

Prochelostoma philadelphi (Robertson)

Clemson, South Carolina, May 6, 1936 (J. N. Todd).

Heriades (Physostetha) gracilior Cockerell

Oak Creek Canyon, Arizona, June 6, 1940 (G. E. Bohart). Males of this species and the very closely related **timberlakei** were taken at the same time and place, but seem to remain distinct from one another.

Heriades (Physostetha) timberlakei Michener

Oak Creek Canyon, Arizona, June 6, 1940 (G. E. Bohart); Lordsburg, New Mexico to Silver City, over 5,000 feet elevation, June 17, 1942 (H. A. Scullen); ten miles northeast of Lordsburg, New Mexico, June 17, 1942 (E. C. Van Dyke). This species has previously been known from Arizona. Doctor Scullen sends another specimen from thirty-two miles west of Prescott, Arizona, June 10, 1942.

Heriades (Physostetha) cressoni Michener

Kyle Canyon, Charleston Mountains, Clark County, Nevada, about 7,500 feet, July 20, 1942 (H. A. Scullen).

Heriades (Neotrypetes) texana Michener

Santa Rita Mountains, Arizona, June 13, 1932. This is the second known specimen of this remarkable species.

[1] Morphologically these are the second to fourth abdominal terga.

Heriades (Neotrypetes) variolosa purpurascens (Cockerell)

Ten miles south of Linares, Nueve Leon, Mexico, December 24, 1940 (C. E. Bohart); Chisos Mountains, Big Bend, Texas, July 4, 1942 (E. C. Van Dyke); Grand Canyon, Arizona, August 19, 1939 (E. C. Van Dyke).

As pointed out in the revision of **Heriades** (Michener, 1938), individuals having the characters of this subspecies occur commonly in Texas. It now seems that Mexican specimens are also **purpurascens** and that the range of this subspecies is from central Texas to Yucatan. Typical **variolosa** ranges northward to Canada.

Heriades (Neotrypetes) variolosa variolosa Cresson

Kaslo, British Colombia, July 23, 1906.

Chelostoma minutum minutum Crawford

Warren, Idaho County, Idaho (J. Bequaert). This is the first record of **Chelostoma** in America outside of the Pacific Coast states.

Chelostoma phaceliae Michener

Clio, Plumas County, California, July 9, 1916 (H. G. Dyar); Eagle Ridge, Klamath Lake, Oregon, June 2, 1924 (C. L. Fox).

Ashmeadiella (Arogochila) cazieri Michener

Sierrita Mountains, Arizona, March 5 to 25 (C. T. Vorhies). This species was previously known only from the deserts of California. The single female from Arizona has the apex of the labrum narrowly bidentate, but this condition is approached in certain California specimens. The Arizona male is indistinguishable from California ones.

Ashmeadiella (Arogochila) foxiella Michener

Craters of the Moon, Butte County, Idaho, June 30, 1937, on **Pentstemon denstus** (F. W. Pennell). This species was previously known from California, Oregon, and Washington.

Ashmeadiella (Arogochila) leachi n. sp.

This species runs to **A. barberi** Michener in the key (Michener, 1939). It differs from that species, the only one to which it is closely related, by its smaller size, more produced and keeled median lobe of the clypeus, shorter and broader head, reduced red areas on the abdomen, etc.

Female: Length 4.5 mm. Facial line subequal to transfacial; inner margins of eyes parallel; clypeus strongly convex and above, shining, coarsely and sparsely punctured; apex of clypeus with a median produced process, truncate apically, provided with a longitudinal median keel; median process demarked by semicircular emarginations lateral to which are the rounded lateral lobes of clypeus; labrum with upper surface polished, apex weekly bidentate; mandibles dark red, quadridentate; genal areas narrower than eyes seen from side; supra-clypeal area, supra-antennal area, and vertex rather finely and closely punctate, genal areas more finely so; flagellum

brown beneath; anterior ocellus much posterior to midpoint between antennal bases and posterior edge of vertex; distance between posterior ocelli greater than distance from one of them to eye or to posterior edge of vertex. Mesoscutum without spots of pubescence anteriorly, punctation like that of vertex, mesoscutellum, and mesepisterna; tegulae dark rufotestaceous; legs black; hind tibial spurs apparently as in **barberi.** Abdomen somewhat more finely and sparsely punctured than mesoscutum, punctures denser posteriorly and laterally; metasomal terga one to five with weak apical bands of pale pubescence; terga one to three with lateral thirds and posterior margins dark red, terga four and five with small lateral areas and posterior margins dark red.

Holotype: Inyo County, California, May 1, 1938 (E. R. Leach), in the collection of the California Academy of Sciences. One paratype with the same data is in the Snow Entomological Collections.

Ashmeadiella (Corythochila) breviceps Michener

Five miles east of Yuma, Arizona, March 22, 1946 (C. D. Michener); Organ Pipe Cactus National Monument, Pima County, Arizona, March 22, 1946 (C. D. Michener).

Ashmeadiella (Chilosima) holtii Cockerell

The specimen recorded from Arizona without further data (Michener, 1939) is now known to be from Phoenix, Arizona (R. E. Kunze). Another specimen is from Maricopa Mountains, Arizona, April 13, 1947 (H. and M. Townes).

Ashmeadiella (Titusella) cubiceps cubiceps (Cresson)

Head of Blitzen River, Steens Mountains, Oregon, 7,000 feet elevation, July 26, 1937 (Bolinger-Jewett); Mount Hood, Oregon, 3,000-6,000 feet altitude, August 6, 1925 (C. L. Fox).

Ashmeadiella (Titusella) biscopula Michener

Santa Catalina Mountains, Arizona, July 20, 1942 (H. A. Scullen); Lordsburg, New Mexico, to Silver City, over 5,000 feet elevation, June 17, 1942 (H. A. Scullen). This is the first New Mexican record for this species.

Ashmeadiella (Ashmeadiella) bucconis bucconis (Say)

Branson, Missouri, September 7 to 19, 1939 (E. C. Van Dyke); Eureka Springs, Ouachita Mountains, Arkansas, September 5, 1939 (E. C. Van Dyke).

Ashmeadiella (Ashmeadiella) bucconis denticulata (Cresson)

Salt Lake City, Utah, August 24, 1917.

Ashmeadiella (Ashmeadiella) opuntiae (Cockerell)

Swissvale, Colorado, June 17, on **Pentstemon** (T. D. A. Cockerell). This specimen is a typical female of **opuntiae,** a new record for Colorado. Although collected on **Pentstemon,** there is **Opuntia** pollen in the scopa.

Ashmeadiella (Ashmeadiella) femorata (Michener)

Twenty miles west of Casa Grande, Arizona, March 23, 1946, on yellow composite (C. D. Michener). The two Arizona specimens (both males), like a few of those from California, have the middle femora red contrary to published descriptions.

Ashmeadiella (Ashmeadiella) maxima Michener

Eagle Pass, Texas, March 28, 1946, on **Gaillardia** (C. D. Michener).

Ashmeadiella (Ashmeadiella) cactorum cactorum (Cokerell)

Lane County, Oregon; South Rim, Crater Lake, Oregon, 7,100 feet altitude, on **Phacelia,** August 21, 1930 (H. A. Scullen). The specific name is not used in the sense of the revision of **Ashmeadiella** (Michener, 1939) but rather in the corrected sense (see Michener, 1942, Ent. News, 53: 49).

Ashmeadiella (Ashmeadiella) meliloti meliloti (Cockerell)

Lordsburg, New Mexico, to Silver City, over 5,000 elevation, June 17, 1942 (H. A. Scullen).

Ashmeadiella (Ashmeadiella) meliloti aridula Cockerell

Murphy, Josephine County, Oregon, July 22, 1941, on sweet clover (J. D. Vertrees).

Ashmeadiella (Ashmeadiella) bigeloviae (Cockerell)

Twenty-five miles east of Mesa, Arizona, June 11, 1942 (H. A. Scullen); Ocotilla, California, March 6, 1947 (G. H. and J. L. Sperry).

Ashmeadiella (Ashmeadiella) coloradensis Cockerell

Badlands National Monument, South Dakota, June 3, 1941 (G. R. Ferguson).

This is the first record for this species outside of Colorado. A useful character for distinguishing females of **coloradensis** from those of its relatives is found in the last exposed sternum, which in **coloradensis** bears a transverse coarsely punctured fovea near the base. Behind this fovea the sternum is finely punctured, this portion of the sternum usually being about as long as the fovea. In most species of **Ashmeadiella** the entire sternum is finely punctured. In **A. foveata** Michener and **A. vandykiella** Michener the coarsely punctured fovea extends nearly to the posterior margin of the sternum. In **A. prosopidis** Cockerell and perhaps **A. schwarzi** Titus the fovea is rather variable, sometimes appearing much as in **coloradensis,** but these are smaller and otherwise different species.

Ashmeadiella (Ashmeadiella) rufiventris Michener

El Mayor, Baja California, Mexico, April 3, 1940, on **Prosopis chilensis** (C. D. Michener). This is the first Mexican record of this species.

Ashmeadiella (Ashmeadiella) prosopidis (Cockerell)

El Mayor, Baja California, Mexico, April 3, 1940, on **Prosopis chilensis** (C. D. Michener). This is the first record of this species from Baja California.

Ashmeadiella (Ashmeadiella) foveata Michener

Pinon Flat, San Jacinto Mountains, California, May 24, 1939, on **Encelia** (E. S. Ross); mouth of Cajon Canyon, San Bernardino County, California, April 25, 1936, in nest under stone (E. G. Linsley).

Ashmeadiella (Ashmeadiella) vandykiella n. sp.

This species is a close relative of **A. foveata** Michener known from a few localities in California. It resembles **foveata** in the large, coarsely punctured, shining fovea of the last exposed sternum of the female, the shining region reaching the posterior margin of the sternum. It differs from that species by the narrower genal areas or cheeks of the female (those of **foveata** appear about two-thirds as wide as the eye, and are scarcely narrower by actual measurement), the presence of a pair of pubescent spots at the anterior end of the mesoscutum, and the absence of a band of white pubescence on the fifth metasomal tergum. In spite of these differences the female of **vandykiella** will run to **foveata** in the key (Michener, 1939). The male runs to **A. cactorum cactorum** (Cockerell)=**meliloti meliloti** (Cockerell) and seems not distinguishable from that form.

Female: Length 6 mm. (abdomen curved downward). Inner margins of eyes converging slightly toward clypeus; facial line subequal to transfacial; flagellum dusky beneath; clypeal truncation feebly concave, its margin shining, ends of truncation rounded, length of truncation greater than distance from end of truncation to eye; clypeus shining and coarsely punctuate except for preapical area which is dull and finely and closely punctuate; supraclypeal area coarsely punctuate and shining like upper part of clypeus, supra-antennal area and vertex more finely and closely punctuate; mandibles dark reddish subapically, distance between second and third teeth very long but total distance from first tooth to third tooth much less than greatest width of eye and less than length of last three antennal segments; genal areas but little more than half as wide as eyes seen from side, finely punctuate; anterior ocellus distinctly behind midpoint between antennal bases and posterior edge of vertex; distance between posterior ocelli greater than distance from one of them to eye margin, subequal to distance to posterior edge of vertex. Mesoscutum with punctation similar to that of vertex, anterior end with a pair of pubescent spots; tegulae reddish black, smooth and shining; mesepisterna slightly more coarsely and sparsely punctate than mesoscutum, markedly more coarsely punctate than genal areas. Wings faintly dusky. Tibial spurs with numerous teeth as in **foveata**. Abdominal terga strongly punctured, punctures of first two metasomal terga slightly finer than those of mesoscutum but remaining terga, especially laterally, with punctures coarser than those of mesoscutum; scopa yellowish white; last exposed sternum with subbasal

transverse shining fovea, provided with very coarse, irregular and widely separated punctures, this type of sculpturing extending to posterior edge of sternum.

Male: Length 5 mm. Apparently not distinguishable from **A. meliloti meliloti** (Cockerell).

Holotype female: Chisos Mountains, Big Bend, Texas, July 4, 1942 (E. C. Van Dyke). The male specimen bears the same data. These specimens are in the collection of the California Academy of Sciences.

Since the type locality of **vandykiella** is probably within the range of **meliloti meliloti,** it is possible that this male is actually that species. However, in this section of the genus, males are known to be difficult to separate, and no female **meliloti** were collected with the **vandykiella.** The male of **foveata,** which might shed light on the matter, is unknown. The presumed male of **vandykiella** is not designated an allotype in view of these circumstances.

Chelostomopsis rubifloris (Cockerell)

Prescott, Arizona, June 10, 1942 (H. A. Scullen); Workman Creek and Parker Creek, Sierra Ancha, Arizona, April 18 and 28, 1947 (H. and M. Townes). The species was previously known only from the Pacific Coast states.

Another locality record is interesting since it is on the east side of the Sierra Nevada. This is Oak Creek Canyon, near Independence, Inyo County, California, on **Pentstemon brevifloris,** May 28, 1937 (C. D. Michener).

Formicapis clypeata Sladen

Fort Resolution, Great Slave Lake, Canada, June 26, 1903, on **Taraxicum** (Mer. Cary); Two Medicine Lodge, Glacier National Park, Montana, July 6, 1938, (E. C. Van Dyke); Horseshoe Lake, Blue Mountains, Oregon, 7,500 feet elevation, July 26, 1929 (H. A. Scullen); Aneroid Lake, Wallowa County, Oregon, August 1, 1941 (R. E. Rieder).

Robertsonella simplex simplex (Cresson)

Savannah, Tennessee, April 13, 1946 (C. D. Michener).

Robertsonella simplex crataegina Cockerell

Maude, Texas, April 7, 1946; Redwater, Texas, April 7, 1946, on **Rubus** (C. D. Michener).

Hoplitis (Dasyosmia) biscutellae (Cockerell)

Twenty miles west of Casa Grande, Arizona, March 23, 1946, on yellow composite (C. D. Michener). This species was expected in this part of Arizona but had never been recorded between southeastern New Mexico and southwestern Arizona.

Hoplitis (Alcidamea) pilosifrons (Cresson)

Fifteen miles north of Harlingen, Texas, April 2, 1946 (C. D. Michener). This is the southernmost record for this species.

Anthocopa (Atoposmia) abjecta (Cresson)

Cornucopia, Oregon, 7,100 feet altitude, July 25, 1936 (H. A. Scullen); Park City, Utah, July 2, 1922 (E. P. Van Duzee); Rawlins, Wyoming, 6,800 feet altitude, June 26, 1920. This species is otherwise known only from Colorado.

Anthocopa (Atoposmia) nigrior Michener

Antelope Mountain, Harney County, Oregon, 6,500 feet altitude, July 6, 1931 (D. K. Frewing).

It seems very likely that this species will fall as a synonym of **abjecta** Cresson, since some of the specimens of **abjecta** recorded above approach **nigrior.**

Anthocopa (Atoposmia) alta (Michener)

Pagosa Junction, Colorado, 6,270 feet altitude, June 7, 1935 (C. R. Rotger).

Anthocopa (Atoposmia) pycnognatha solatus, new supspecies

This subspecies closely resembles true **pycnognatha.** It differs as follows: Size smaller, especially in male (length of female 7 to 8.5 mm., of male 7.5 to 8 mm.); genal areas of male less finely and closely punctate; median ocellus of female well behind midpoint between antennal bases and posterior edge of vertex.

Holotype female, allotype male, and nine paratypes from Gavilan, California, May 29, 1946, on **Pentstemon anterrhinoides** (P. H. Timberlake). Two paratypes from one and one-half miles west of Perris, California, May 4, 1938, one on **Salvia columbaria.** It is interesting that **Pentstemon anterrhinoides** is a close relative of the flower visited by typical **pycnognatha, Pentstemon brevifloris.**

The holotype, allotype and some paratypes are being returned to the Timberlake collection at the Citrus Experiment Station, Riverside, California. Other paratypes are being placed in the Snow Entomological Collections, and in the American Museum of Natural History.

Anthocopa (Hexosmia) copelandica (Cockerell)

Penticton, British Columbia, June 4, 1930 (E. R. Buckell).

Anthocopa (Phaeosmia) mallognatha Michener

This species, previously recognized only from a female from Inyo County, California, is now known from a series of both sexes from twenty miles west of Casa Grande, Arizona, March 23, 1946, on yellow composites (C. D. Michener). Another locality is Maricopa Mountains, Arizona, April 13, 1947 (H. and M. Townes). Most but not all of the Arizona females differ from the holotype, kindly lent for examination by Doctor E. S. Ross of the California Academy of Sciences, by having the clypeal truncation straight to slightly convex instead of concave. Female specimens vary in length from 7 to 9 mm.

Male: Length 7.5 mm. Similar in appearance to female. Inner orbits of eyes subparallel; clypeus finely and densely punctate in contrast to

rest of head, covered with long dense white pubescence; anterior margin of clypeus impunctate, strongly and irregularly denticulate with about six conspicuous teeth, median ones not larger than the others; area behind ocelli neither more coarsely nor more sparsely punctate than rest of head; mandibles slightly narrowed to apices so that breadth at apex of inner tooth is markedly less than breadth a short distance basad of that point; tegulae black; sixth metasomal tergum with rather narrow flange forming the broadly rounded margin, this margin ending at each side in a broadly rounded, unproduced angle; second metasomal sternum large, its margin with shallow median emargination; third sternum largely hidden by second, broadly emarginate, emargination fringed with long yellow hairs which are longest laterally; fourth sternum broadly rounded posteriorly.

In both sexes the narrow white abdominal fasciae are strong only on the first three metasomal terga, on the fourth the fascia is conspicuous only in certain lights, and on the fifth the fascia is virtually absent.

This species was originally described, with much hesitation, in the subgenus **Eremosmia.** The discovery of the male shows clearly that it is actually a **Phaeosmia** and also that the principal character used to separate these subgenera in the females (see Michener, 1943) breaks down. The two subgenera remain readily distinguishable by the male characters, the most conspicuous of which are the tridentate mandibles of **Eremosmia** in contrast to bidentate ones in **Phaeosmia.**

Anthocopa (Phaeosmia) anodontura (Cockerell) (new combination)

Hoplitis anodontura Cockerell, 1917, Ann. Mag. Nat. Hist., (8) 20 : 325.

This species was omitted from the revision of **Anthocopa** (Michener, 1943) as it was not realized that it belonged to the genus. The type (in the United States National Museum) is from Cuernavaca, Morelos, Mexico, September to October, 1897 (F. C. Baker collection). It falls clearly in the subgenus **Phaeosmia** although differing from the diagnosis of that subgenus in the relative lengths of the segments of the labial palpi.

Male: Pubescence white, particularly long and abundant on face. Inner orbits subparallel; head rather coarsely and closely punctate, clypeus more finely and very closely punctate; anterior margin of clypeus rather broadly impunctate, truncation about three times as long as distance from its end to lateral angle of clypeus, with six denticles, the median pair largest and widely separated from one another, the lateral ones small and inconspicuous; mandibles not narrowed apically as in **A. mortua;** first segment of labial palpus about half as long as second. Thorax rather coarsely and closely punctate, the mesoscutum with punctation similar to that of vertex; upper part of enclosure of propodeum roughened; tegulae black. Abdomen closely punctured, the margins of the terga finely so; first five metasomal terga provided with narrow apical bands of white pubescence; sixth tergum broadly rounded at apex with narrow projecting brownish flange on margin and with a broadly rounded angle at side; second sternum large, the posterior margin convex; third apparently broadly emarginate, but hidden except laterally by third; fourth with margin convex.

Anthocopa (Phaeosmia) hypostomalis n. sp.

This is a very distinctive species of **Anthocopa.** Superficially it looks like **A. mortua** or **hemizoniae** except for its somewhat more slender form. A very striking character is the broad head, the face being markedly broader than long, the inner orbits slightly diverging below. Another remarkable character is to be found in the hypostomal region, which is very short from front to rear, so that the longitudinal parts of the hypostomal carinae are shorter than the transverse parts. These carinae are strongly elevated posteriorly. The punctation, especially that of the abdomen, is finer than in other species of **Phaeosmia.**

Female: Length 10 mm. Pubescence white, that of dorsum of head, thorax, and abdomen largely fuscous; brushes under margin of clypeus small, orange. Inner margins of eyes slightly diverging below; punctation of head rather coarse and dense, unusually fine in a small area in front of each ocellus; upper three-fifths of clypeus convex with punctation like that of rest of head, lower two-fifths flat, much more coarsely punctate except for the shining impunctate margin of truncation; truncation slightly longer than distance from end of truncation to lateral angle of clypeus, not thickened, feebly emarginate medially, demarked by very broadly rounded angles; distance between posterior ocelli subequal to distance to eye margin, markedly less than distance to posterior margin of vertex; anterior ocellus at or slightly in front of midpoint between antennal bases and posterior margin of vertex; genal areas nearly as wide as eyes seen from side; hypostomal areas finely and closely punctate, provided with long curved hairs, these areas unusually broad so that transverse portions of hypostomal carinae are longer than longitundinal portions; mandibles slightly less than three times as long as least breadth, dark reddish subapically, distance between first and second teeth slightly greater than distance between second and third; subapical inner swelling inconspicuous; maxillary palpi longer than greatest width of galea, four-segmented, third segment much the longest, other three segments subequal; labial palpi with first segment to second as 7 is to 11. Mesoscutum and mesepisterna slightly more coarsely and less closely punctate than vertex; tegulae translucent brownish; legs, including tibial spurs, black; wings slightly dusky. Abdomen finely punctate with surface somewhat dull, especially middorsally, punctation extending almost to posterior margins of terga, which are very feebly brownish; posterior margins of metasomal terga one to four with conspicuous broad bands of white pubescence, those of one and two broken medially, scopa short, sparse, dull white.

Holotype female: Cabazon, Riverside County, California, June 1, 1944, (E. C. Van Dyke) in the collection of the California Academy of Sciences.

Anthocopa (Phaeosmia) maryae n. sp.

This small species is most closely related to **A. rubrella,** from which it differs by lacking the red color, by having merely a pair of weak angles instead of a pair of teeth in the middle of the clypeal truncation of the female, and by having the distance between the posterior ocelli of the female much

greater than the distance from one of them to the posterior margin of the vertex.

Female: Length 6.5 mm. Body black, pubescence dull white mixed with fuscous on dorsum of head, thorax, and abdomen; tufts of hairs beneath clypeal margin small, orange brown; inner margins of eyes converging below; punctation rather coarse, that of head uniform and rather dense except for upper two-thirds of clypeus which is convex, more shining and more coarsely and slightly less closely punctate; lower third of clypeus dull, closely punctate; clypeal truncation with rather broad impunctate margin, truncation slightly longer than distance from its end to lateral angle of clypeus, slightly concave, with a pair of submedian angles (fig. 10); distance between posterior ocelli slightly less than distance from one of them to eye margin, much greater than distance from one of them to posterior edge of vertex; median ocellus twice as far from antennal bases as from posterior edge of vertex; genal areas much narrower than eyes seen from side; mandibles dark red subapically, almost three times as long as greatest breadth, distance between first and second teeth slightly greater than that between second and third, subapical inner swelling weak; maxillary palpi short, about as long as greatest width of galea, four-segmented, second and third segments subequal, longer than other two; first segment of labial palpus five-sixths as long as second. Thorax dorsally little if at all more coarsely punctate than vertex, mesepisterna slightly more coarsely punctate than mesoscutum, especially below, and distinctly more coarsely punctate than genal areas; tegulae hardly roughened, brownish posteriorly; legs black, tibial spurs dark brown to black; wings faintly dusky. Abdomen black, posterior margins of terga slightly brownish, metasomal terga one to three with medially broken apical bands of white pubescence; punctation of terga about as coarse as that of mesoscutum, but middorsal portions of first few terga more sparsely punctate; posterior margins of terga narrowly impunctate or nearly so; sixth tergum with apical flange projecting at an angle to disc of tergum; scopa short, yellowish white, sparse.

Holotype female and one paratype: Eagle Pass, Texas, March 28, 1946, on **Gaillardia** (Mary H. and C. D. Michener). There is not much pollen on the scopa and there is no certainty that this bee was collecting from **Gaillardia**.

This species is named for my wife, Mary H. Michener.

These specimens were collected for the American Museum of Natural History, and the holotype is in that institution. The paratype is in the Snow Entomological Collections.

Anthocopa (Phaeosmia) rubrella n. sp.

This Texan species differs from all other American species of **Anthocopa** by having the basal half of the abdomen red. The two adjacent teeth of the clypeal margin of the female suggest **A. panamintensis**, a very different, black species with tridentate mandibles in the male.

Female: Length 6 mm. to nearly 7 mm. Head and thorax black, provided with white pubescence, that of vertex and dorsum of thorax and abdomen somewhat dusky; tufts of hairs beneath clypeal margin orange brown; inner

margins of eyes slightly converging below; punctation rather coarse, that of head (except clypeus) uniform and rather dense; upper two-thirds of clypeus strongly convex and somewhat protuberant, much more coarsely punctate and more shining than rest of head, punctures separated by one-third of their diameters or less; lower third of clypeus dull, very closely punctate, punctures about the size of those of genal areas; clypeal margin rather broadly impunctate, truncation about as long as distance from end of truncation to lateral angle of clypeus, strongly concave if a pair of rather large submedian teeth are ignored (fig. 11); distance between posterior ocelli equal to distance from one of them to posterior edge of vertex or to eye margin; median ocellus behind midpoint between antennal bases and posterior edge of vertex; genal areas narrower than eyes seen from side; mandibles dark red subapically, about three times as long as least breadth, distance between first and second teeth slightly greater than distance between second and third, subapical inner swelling weak; maxillary palpi short, about as long as greatest width of galea, four-segmented, second segment longest, first and third subequal in length, fourth minute; first segment of labial palpus five-sixths as long as second. Thorax dorsally very slightly more coarsely punctate than vertex, mesepisterna slightly more corsely punctate than mesoscutum, especially below, and distinctly more coarsely punctate than genal areas; tegulae hardly roughened, brownish posteriorly; legs black, tibial spurs black; wings faintly dusky, second recurrent vein well beyond second transverse cubital, as in **Ashmeadiella.** Abdomen black, first three metasomal terga red (sometimes black middorsally); base of fourth tergum reddish, and posterior margins of following ones brownish; posterior margins of metasomal terga one to three with narrow white hair bands, fourth tergum with weak hair band; abdominal punctation dorsally on first few metasomal terga finer than that of mesoscutum, but punctation of posterior terga and sides of the others as coarse as and sometimes closer than that of mesoscutum; posterior margins of terga narrowly impunctate or nearly so; sixth tergum with a brownish flange projecting at an angle to the disc of the tergum; scopa short, sparse, white.

Male: Length 5 to 5.5 mm. Similar in appearance and punctation to female; punctures of shining upper part of clypeus not as coarse as in female; inner margins of eyes subparallel; clypeal margin roughly transverse, median third or truncation not produced, scarcely overhanging base of labrum, narrowly impunctate, slightly thickened, smoothly and gently concave, demarked laterally by distinct angles; lateral portions of clypeal margin more broadly impunctate, each a sigmoid curve; mandibles bidentate, outer tooth longest. Abdomen with first four metasomal terga red, the fourth at least blackish middorsally; posterior margins of terga brownish; pubescent bands nearly absent (possibly worn off in the types); sixth tergum with a projecting flange somewhat as on sixth tergum of female, posterior margin of this tergum broadly truncate if viewed from behind but gently convex seen from above, margin produced laterally to a broadly rounded angle; seventh tergum but little exposed, truncate, rounded laterally; second, third, and fourth sterna

subequal in size, posterior margins gently rounded, those of second and third sterna provided with fringes of long white hairs.

Holotype female, allotype male, and a paratype of each sex: Dryden, Texas, March 27, 1946, on a small legume (C. D. Michener). The holotype and allotype are in the collection of the American Museum of Natural History; the paratypes are in the Snow Entomological Collections.

As there are now nine known species of the subgenus **Phaeosmia**, compared to four at the time the revision of **Anthocopa** (Michener, 1943) was prepared, it seems necessary to present new keys to the species of this subgenus. It should be pointed out that the extensions in the known range of **Phaeosmia** are very great. This group, previously known only from California, is here recorded eastward to Texas and southward to Morelos, Mexico. It thus does not fit into the distributional picture outlined previously for the genus **Anthocopa**.

Keys to the Species of Phaeosmia
Females

1. Apical margin of sixth metasomal tergum with a broad thin flange projecting almost at right angles to the disc of the tergum; clypeal margin with a pair of median angles or teeth; length under 7 mm. 2
   Apical margin of sixth tergum without such a flange; clypeal margin without a pair of median angles or teeth; length over 7 mm. 3
2. Abdomen black; clypeus with a pair of median angles ..... (Texas) **maryae** Michener
   Abdomen red basally; clypeus with a pair of median teeth ..... (Texas) **rubrella** Michener
3. Inner margins of eyes diverging below; longitudinal portions of hypostomal carinae shorter than transverse portions ..... (California) **hypostomalis** Michener
   Inner margins of eyes parallel or converging below; longitudinal portions of hypostomal carinae longer than transverse ones 4
4. Mandibles narrowed medially so that each is more than four times as long as shortest breadth ..... (California, Arizona) **mallognatha** Michener
   Mandibles robust, less than four times as long as greatest breadth 5
5. Clypeal truncation about two-thirds as long as distance from its end to lateral angle of clypeus; ends of truncation marked by distinct, although narrowly rounded, angles ..... (California) **mortua** Cockerell
   Clypeal truncation about as long as distance from its end to lateral angle of clypeus; ends of truncation broadly rounded 6

6. Apex of clypeus gently emarginate between broad, rounded lobes which form the ends of truncation; scopa yellowish white ..... (California) **hemizoniae** Cockerell
Apex of clypeus not or extremely slightly emarginate; scopa darker 7
7. Distance between posterior ocelli equal to distance from a posterior ocellus to eye margin; anterior margin of clypeus directed forward, at distinct angle to lower disc of clypeus; scopa brown..... ..... (California) **enceliae** Cockerell
Distance between posterior ocelli conspicuously less than distance to eye margin; anterior margin of clypeus not strongly directed foreward; scopa pale ferruginous ..... (California) **viguierae** Cockerell

Males

1. Second and third metasomal terga subequal in size, posterior margins gently rounded....(Texas) **rubrella** Michener
Second sternum much larger than third which is largely hidden by second; posterior margin of third with broad, deep emargination 2
2. Mandibles narrowed apically so that breadth at apex of inner tooth is markedly less than breadth a short distance basad of that point 3
Mandibles not narrowed apically, breadth at apex of inner tooth but little less than breadth basad of that point 4
3. Apex of second sternum narrowly subtruncate medially; clypeal margin weakly crenulate .... (California) **mortua** Cockerell
Apex of second sternum emarginate medially; clypeal margin strongly denticulate .... (California, Arizona) **mallognatha** Michener
4. Inner orbits of eyes subparallel; second sternum with margin convex ..... (Morelos) **anodontura** Cockerell
Inner orbits of eyes converging below; second sternum with feeble median emargination .... (California) **enceliae** Cockerell

Anthocopa (Xerosmia) xerophila (Cockerell)

Borego, California, February 28 and March 6, 1947 (G. H. and J. L. Sperry).

Anthocopa (Eremosmia) laevibullata Michener

Tallac, El Dorado County, California (W. M. Giffard). This is the third known specimen of this species.

Osmia (Acanthosmioides) nigrobarbata Cockerell

Osmia nigrobarbata Cockerell, 1916, Pomona Jour. Ent. Zool., 8: 52, ♀.
Osmia vanduzeei Sandhouse, 1924, Proc. Calif. Acad. Sci., (4) 13: 343, ♂ (new synonymy).

There is no longer any doubt of this synonymy. The sexes have been collected together in the San Bernardino Mountains, California, on several occasions.

Osmia (Acanthosmioides) physariae Cockerell

Osmia physariae Cockerell, 1907, Ann. Mag. Nat. Hist., (7) 20: 446.
?Osmia erecta Michener, 1936, Canad. Ent., 68: 40.

Miss Sandhouse wrote me before her death that she had incorrectly placed **erecta** in the synonymy of **nifoata** (Sandhouse, 1939), and that actually it was a synonym of **physariae.** If the ventral abdominal characters are actually as variable as she believed, this is doubtless correct.

Osmia (Acanthosmioides) unca Michener

Osmia unca Michener, 1937, Ann. Mag. Nat. Hist., (10) 19: 406.
Osmia hicksi Sandhouse, 1939, Mem. Ent. Soc. Washington, 1: 53 (new synonymy).

This synonymy was indicated to me (in litt.) by Sandhouse.

Osmia (Nothosmia) glauca (Fowler)

Heriades glaucum Fowler, 1899, Psyche, 8: 405.
Osmia exilis Sandhouse, 1924, Proc. Calif. Acad. Sci., (4) 13: 351 (new synonymy).

The type of this species is lost, but the species is so distinctive that there seems no doubt of this synonymy. We have practically no other species small enough to be confused with **Heriades.**

The following species are among the doubtful species of Sandhouse (1939). The comments are based upon the types in the California Academy of Sciences. Color and other characteristics mentioned in the original descriptions are omitted from the following notes.

Osmia (Nothosmia) solitaria Sandhouse

Near **O. justa** Cresson and **densa** Cresson but evidently distinct. Second segment of flagellum nearly twice as long as first; vertex and mesoscutum with dark hairs intermixed (as in **densa**); legs metallic (as in **densa**); strigilis truncate with short outer apical spine; tooth on hind basitarsus between one-third and one-fourth length of segment from apex, not so broad as in **juxta;** median emargination of fold of seventh tergum much broader than a semicircle.

Osmia (Nothosmia) nelsoni Cockerell

Runs to **O. marginipennis** in the key (Sandhouse, 1939), but differs in the conspicuously emarginate clypeal truncation, the darker pubescence,

and the genal areas which are broader than the eye seen from side. In the clypeal structure and widths of the genal areas this species resembles **O. subaustralis** Cockerell, from which it differs in the form of the hypostomal carinae.

Osmia (Acanthosmioides) crenulaticornis Michener

This is a distinct species, not close to **enixa** Sandhouse. It differs from **enixa** by the short, triangular process at the apex of the second metasomal sternum, this process and the entire median part of sternum shining and impunctate, devoid of hairs; superior apical angle of mandible apparently about a right angle; margin of sixth metasomal tergum practically not emarginate; seventh tergum with median projection narrow, with smaller emargination than in **enixa,** this emargination wider than deep.

This species runs best in the Sandhouse key to the region of **O. physariae** Cockerell and **nifoata** Cockerell. It differs from the latter by the much reduced process of the second sternum, by having the longest hind tibial spur half as long as the basitarsus, etc. It differs from **O. physariae** thus: Fore basitarsus more than three times as long as wide; strigilis truncate with short apical spine; hind basitarsus slightly broader apically than basally; visible sterna (2-4) as described for **physariae,** but apical process of second smaller. Process of genital coxopodite longer than in **physariae.**

Osmia (Nothosmia) potentillae Michener

This species runs close to **zephyros** Sandhouse and **caulicola** Cockerell in the Sandhouse key (1939).

Female: Apical margin of mandible with upper portion oblique, separated from tooth below by V-shaped notch, this tooth separated from lowest tooth (which is short) by right angular V-shaped notch; mandibular carinae subparallel, the lower broader than the upper; first segment of labial palpus two-thirds length of second; second segment of maxillary palpus slightly shorter than third; fourth conspicuously longer than fifth, fourth plus fifth equal in length to third; clypeus rather strongly convex, and coarsely punctured above the slightly depressed, feebly concave apical margin; distance between posterior ocelli slightly less than distance to posterior margin of head, distinctly less than distance to eye; punctuation of mesoscutum similar to that of vertex, coarser than that of genal areas; punctures of upper part of mesepisternum separated by areas furnished with minute punctures; strigilis oblique at apex; anterior tarsi without hamate bristles; hypostomal carina rather low, highest a short distance behind angle and reduced to angle; propodeal triangle shining below, upper half finely roughened; posterior tibial spurs somewhat bent at apices; apical margins of abdominal terga with narrow impunctate bands.

Differs from **O. caulicola** to which it is probably closest, by the smaller size, the proportions of the segments of palpi, and other characters.

Osmia (Nothosmia) mixta Michener

This species does not run well in the Sandhouse (1939) key. It differs from **O. malina** Cockerell by the form of the mandibles, the truncate strigilis,

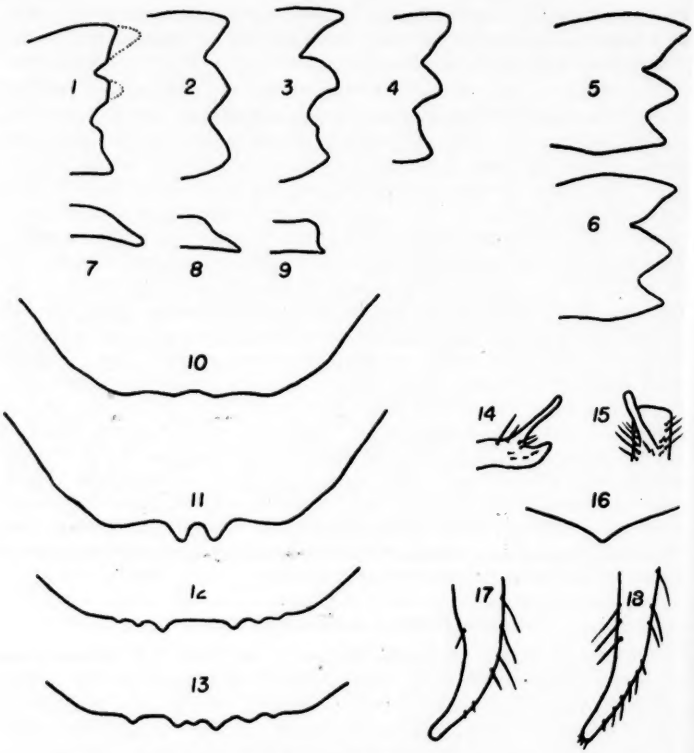
the vertex which, except in region of ocelli, is but little more finely punctate than the mesoscutum (although both coarsely punctate) and presumably by the hairs on the maxillae.

Mandibular carinae distinctly converging apically, inferior one, apically, more than twice as thick as superior one, the base of which is directed toward upper basal angle of mandible; upper margin of mandible with strong carina on basal three-fourths; upper apical angle about a right angle (for shape of apex of mandible, see figure). Galea of maxilla with long, hamate bristles on outer side; first and second segments of labial palpi furnished on inner margins with a row of long straight bristles pointing distad, but without hamate bristles; first segment of labial palpus about three-fourths as long as second; second segment of maxillary palpus longer than any other segment, last segment of maxillary palpus about one-half as long as next to last, first segment very short; hypostomal carina moderately high, reduced at angle; truncation of clypeus produced but not thickened, impunctate margin broad, margin of truncation feebly concave; distance between posterior ocelli about equal to distance to posterior edge of vertex and less than distance to eye; cheeks as coarsely punctate as area around ocelli, more finely punctate than rest of head and thorax; strigilis subtruncate with a short apical spine; fore tarsi without long hamate bristles; metanotum shining and very sparsely punctate; triangle of propodeum shining below, rather coarsely reticulate above; hairs of wings long and rather sparse; hind tibial spurs somewhat curved apically; impunctate bands of abdominal tergites of moderate width.

Osmia (Nothosmia) sequoiae Michener

This species, like **O. potentillae** Michener, runs close to **O. sanctae-rosae** Cockerell, **caulicola** Cockerell, and **zephyros** Sandhouse. It differs from **sanctae-rosae** in size, color, color of pubescence (see original description), and in the non-confluent nature of the lateral punctures of the mesoscutum. It differs from **zephyros** by the shape of the strigilis, from both **zephyros** and **caulicola** by the shorter lower tooth of the mandible, from **potentillae** by larger size, strongly reticulate upper part of the propodeal triangle, and the proportions of the segments of the maxillary palpi.

Apical margin of mandible with upper portion oblique, forming an upper tooth, lower tooth not or hardly exceeding middle tooth; mandibular carinae slightly converging apically, lower one about twice as broad as upper; first segment of labial palpus two-thirds as long as second; second and third segments of maxillary palpi subequal, fifth hardly shorter than fourth, fourth plus fifth together hardly longer than third; clypeus rather strongly convex above the slightly concave, depressed, impunctate apical margin; measurements of vertex as in **potentillae**; hypostomal carina rather low, highest a short distance behind angle; punctures of mesoscutum similar to those of vertex (both these areas are black), much coarser than those of cheeks; punctures of upper part of mesepisternum separated by areas furnished with minute punctures; strigilis oblique at apex, with a stout



Explanation of Figures

1-6 Apices of mandibles of females. 1. **Osmia tokopahensis**; 2, **O. sequoiae**; 3, **O. mixta**; 4, **O. potentillae**; 5, **Anthocopa rubrella**; 6, **A. maryae.**

7-9 Apices of strigilis of females. 7. **Osmia tokopahensis**; 8. **O. sequoiae**; 9, **O. mixta.**

10-13 Clypeal margins. 10, **Anthocopa maryae**, female; 11, **A. rubrella**, female; 12, **A. anodontura**, male; 13, **A. mallognatha**, male.

14-16 **Osmia crenulaticornis**, male. 14, side view of apex of gonocoxite; 15, dorsal view of same. 16, apical margin of second sternum.

17-18 Apices of male gonocoxites. 17, **Anthocopa mallognatha**; 18, **A. anodontura.**

apical spine; anterior tarsi without long hammate bristles; upper part of propodeal triangle more coarsely reticulate than in **potentillae;** posterior tibial spurs somewhat bent at apices; apical impunctate margins of terga relatively broad.

Osmia (Nothosmia) tokopahensis Michener

This species runs to **O. dolerosa** Sandhouse in the key, and agrees in general with the description, although the type of **tokopahensis** is badly

worn. It differs from the description of **dolerosa** in that the first two segments of the labial palpus are equal in length (a rather unusual character). The mandibles are broadened apically, worn in the type, but the characters indicated in the figure may distinguish this species from **dolerosa.** The distance between the posterior ocelli is slightly less than the distance to the posterior edge of the vertex, considerably less than the distance to the eye margin. The hypostomal carinae are not reduced at the angles, seemingly being highest lateral to the angles. This species differs further from **dolerosa** in certain characters of the pubescence which are described in the original description.

The following additional characters may help to further distinguish **tokopahensis** from **dolerosa** and other species.

Upper mandibular carina bent upward basally and directed toward upper articulation of mandible; hairs of area lateral to hypostomal carina rather long, those of anterior part of this region bent inward at apices; strigilis with an oblique, blunt apex; punctures of genal areas fully as coarse as those of median part of supra-antennal area and confluent; punctures of median part of supra-antennal area slightly finer than those of rest of face, slightly confluent, especially below; punctures of mesoscutum quite close, not coarser than those of vertex; punctures of mesepisterna slightly separated, without punctures in interspaces.

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SOME NEW SPECIES OF NEPIDAE (HEMIPTERA)

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Telmatotrephes grandicollis sp. n.

Size: Male: Length 26 mm., greatest transverse width 13 mm., length of respiratory tubes 4.5 mm. Female: Length 26 mm., width 13.5 mm., length of respiratory tubes 4.5 mm.

Shape: A short, broad species; length twice greatest transverse width. Width of inter-ocular space almost two and one-half times transverse diameter of one eye. Hemelytra widening gradually to posterior third where they cut in abruptly and end in a gentle curve, giving margin of posterior third of hemelytra a concave appearance.

Structural Characteristics: Transverse width of interocular space subequal to half the median length of head measured from the anterior margin of jugae to posterior margin of vertex. Jugae large, meeting dorsally for a portion of their length. Prominent median carina extends from middle of jugae slightly beyond anterior margin of eyes, and continues less prominently to posterior margin of vertex; two lateral oblique carinae between anterior margin of eye and the tylus, these converging posteriorly with the median carina posterior to posterior margin of eyes. Another pair of lateral longitudinal carinae start at middle of eye and join the median carina just before posterior margin of vertex. Pronotum rectangular, anterior margin deeply emarginate, the emargination one-third of the length of pronotum. Head sunken in anterior emargination of pronotum beyond posterior margin of eyes. Posterior width of pronotum two times its median length. Posterior margin of pronotum not emarginate. Two lateral carinae begin at anterior margin of pronotum just posterior to center of eyes; these diverge laterally a short distance, then converge gradually, and meet on posterior fourth to form a median carina running to the posterior margin. Anterior lateral discs with prominent short carinae.

Width of anterior margin of scutellum one and one-half times the median longitudinal length; two prominent lateral carinae start at anterior margin, run almost half the length, ending in a prominent diamond-shaped gibbosity. Hemelytra with raised lateral margins on anterior half; median margins raised, running to the very small membrane. Oblique carinae starting out prominently at anterior margin of hemelytra and gradually fading out after running about one-fourth of the length. Lateral margin of hemelytra cutting in abruptly to form a concave curve on posterior third. Membrane very small. Respiratory tubes compressed laterally and about one-fourth the length of the hemelytra. Anterior femur two and one-half times median length of pronotum, widest at base and narrowest at apex; wide, deep trough running entire ventral length in which anterior tibia can be folded; lobes

*Contribution from the Department of Entomology, University of Kansas.

on ventral side at base where femur joins the coxa. Anterior tibia three-fourths length of femur. Anterior coxa short and stout.

Antenna simple, basal segment globular, last segment longest.

Prosternum with large depressions in which anterior coxae are situated, these running posteriorly as sulci to posterior margin without joining medianly; prominent narrow median carina widens into a disc and gradually fades out. Metasternum less than three-fourths the length of mesosternum, both about same width; metasternum widely and deeply emarginate posteriorly, posterior lateral lobes acutely produced.

Margin of abdomen embraced by submarginal fold of the hemelytra. Median length of penultimate abdominal segment greater than combined length of all others preceding it. Operculum slightly longer than last abdominal segment, spoon-shaped.

Metathoracic wings absent. Tibia of mesothoracic leg perceptibly shorter than femur; tibia of metathoracic leg slightly shorter than femur. Metathoracic tarsus one-third longer than mesothoracic tarsus. Meso- and metathoracic femora distinctly wider and stouter than their respective tibiae.

Distribution: Holotype, allotype and one female paratype. Holotype and allotype from Rio Santiago, Peru, in the Bassler Collection of the American Museum of Natural History. Female paratype from Upper Rio Tapiche, Peru, in the Snow Entomological Collections.

Notes: This species is easily distinguished from **T. sculpticollis** Stål by the concave lateral margin of the posterior third of the hemelytra. Numerous little clusters of hairs are present over most of the body and legs.

Curicta bilobata sp. n.

Size: Male: Length from tip of beak to tip of abdomen 19.5 mm., length of respiratory appendages 12.5 mm., width of head through eyes 1.8 mm., anterior width of pronotum 2.4 mm., posterior width of pronotum 3.3 mm., median length of pronotum 3.5 mm.

Color: A uniform light brown color.

Shape: Lateral sides of abdomen parallel for almost two-thirds their length; sides of prothorax almost parallel on anterior half and diverging outwardly on posterior half.

Structural Characteristics: Length of head from anterior margin of eyes slightly greater than length from posterior margin of eye to posterior margin of vertex. Width of one eye slightly less than one-half width of interocular space. Jugae closely appressed to tylus and not distinct. Anterior margin of pronotum deeply and roundly emarginate with posterior margin not as deeply emarginate, but emargination broadly rounded. Median longitudinal length of pronotum slightly greater than posterior width; lateral length of pronotum two-fifths greater than greatest posterior width. Carinae on pronotum absent; short median fossa on anterior pronotum and two broad, shallow, lateral sulci at middle of pronotum which converge posteriorly and end in transverse grooves. Scutellum plain with rounded lateral sides, ending in an acute angle; median longitudinal length greater than width at base. Hemelytra plain and having a membrane. Dorsum of last abdominal segment

with two lateral, longitudinal, prominent plates which fold mesally and touch each other medianly for half their length.

Penultimate segment of antenna having a lateral prolongation a little more than half the length of ultimate segment. Anterior coxa prismatic in shape and 3 mm. long. Anterior femur 5.9 mm. in length; femoral tooth indistinct and located at the middle of the femur. Width of femur beyond the femoral tooth greater than width of femur before the femoral tooth. Length of anterior tibia a little less than half the length of femur; anterior tarsus short, indistinct and hardly reaching to middle of femoral tooth. Prosternum with anterior median portion raised between the coxal cavities; prominent wide sulci running posteriorly, originating behind coxal cavities and curving in posteriorly to meet just in front of posterior margin of prosternum. (These sulci may be filled with hairs). Meso- and metasterna not prominently swollen. Mesosternum having two faint longitudinal carinae. Posterior margin of metasternum broadly and roundly emarginate with lateral margins ending in rather sharp teeth leaving a large portion of the raised first abdominal segment exposed. Operculum a little longer than any one of the preceding four sternites. Connexiva widened and terminating posteriorly in prominent mesal projections which extend beyond posterior margin of operculum.

Distribution: This species is described from a single male specimen from Espirito-Santo, Brazil (Fruhstorfer).

The specimen was borrowed from the Wien Museum.

Notes: This species is close to **C. scorpio** Stål. It is easily distinguished by the shape of the anterior femur and by two large longitudinal plates on the dorsum of the last abdominal segment for which the species receives its name.

Curicta carinata sp. n.

Size: Male: Length from tip of beak to tip of abdomen 19.5 mm. to 21 mm., length of respiratory appendages 11 mm., posterior width of pronotum 3.1 mm., median longitudinal length of pronotum 3.3 mm. Female: Length 22 mm. to 23.5 mm., length of respiratory appendages 12 to 14 mm., posterior width of pronotum 3.5 mm., median longitudinal length of pronotum 3.8 mm.

Color: In general light brownish but varies to brownish black.

Shape: Elongate oval. Pronotum trapezoidal with median longitudinal length slightly greater than posterior width. Prominent median carina on vertex and four less prominent lateral longitudinal carinae on pronotum anterior to transverse grooves.

Structural characteristics: Anterior part of head triangular, length of head from anterior margin of lora to anterior margin of eye slightly less than length of head from posterior margin of eye to posterior margin of vertex. Jugae closely appressed to tylus, slightly diverging and not reaching level of tylus. Posterior interocular portion of head with prominent median longitudinal carina. Eyes small, transverse width of one eye not appreciably greater than one-half width of interocular space. Width of head through eyes 1.9 mm.

Pronotum with anterior margin deeply and angularly emarginate. Head set into prothorax; anterior lateral lobes of prothorax reach to posterior margin of eyes. Posterior margin of pronotum deeply and roundly emarginate. Anterior width of pronotum 2.6 mm., distinctly less than posterior width; median longitudinal length 3.6 mm., slightly greater than posterior width of pronotum. Prominent median longitudinal sulcus on anterior half and two prominent lateral longitudinal sulci which end in transverse grooves; two lateral carinae between median and lateral sulci which run out on posterior portion behind transverse grooves and two others which begin at anterior margin of pronotum directly posterior to middle of eye and run to transverse grooves. Lateral sides of pronotum subparallel at middle and widened anteriorly and more prominently posteriorly.

Scutellum a little longer than wide at base, triangular, with posterior lateral sides slightly concave so that scutellum ends in an acute angle; tricarinate, median longitudinal carina very prominent on posterior half, lateral carinae indistinct and divergent posteriorly.

Hemelytra with numerous tubercles, lateral sides of basal halves subparallel, claval suture three times length of scutellum, membrane long and rounded posteriorly. Respiratory appendages shorter than abdomen.

Antenna with lateral prolongation of penultimate segment slightly more than one-half length of ultimate segment. Prosternum between anterior coxae prominently raised on median line, elevation running out near middle. Longitudinal sulci, originating posterior to coxal cavity, run out at posterior margin of prosternum without joining. Mesosternum with two lateral, rather distinct and prominent, longitudinal carinae. Mesosternum swollen and inflated so that its ventral margin is not on a line with that of prosternum and metasternum. Posterior margin of metasternum broadly emarginate with lateral margins forming sharp lobes at posterior margin. Length of fifth abdominal sternite subequal to length of each of preceding three sternites. Genital operculum relatively long and narrow ending in a rather acute angle. Connexivum broad, ending in a mesal tooth-like lobe which extends beyond operculum.

Anterior femur 5.2 mm. in length, which is slightly greater than lateral length of prothorax. Femoral tooth situated at middle of femur, small and rounded, divided into two parts by femoral sulcus. Anterior tibia when folded against femur not reaching femoral tooth, less than half the length of femur. Anterior tarsus extends slightly beyond anterior margin of femoral tooth when tibia is folded against femur. Length of anterior coxa 2.7 mm., slightly greater than anterior width of pronotum.

Intermediate tibia a little shorter than intermediate femur. Posterior tibia, subequal to length of posterior femur. Length of posterior tarsus a little more than one and one-half times length of intermediate tarsus.

Distribution: Holotype, allotype and 12 female and 12 male paratypes from Villerrica, Paraguay, S. A. (F. Schade). Also 12 males and 13 females from same locality and 15 males and 10 females from Coraveni, Paraguay, S. A. (F. Schade). All specimens in the Snow Entomological Collections.

Notes: This new species is closely related to **C. intermedia** Martin. It is readily distinguished from it by the very prominent median carina on the posterior interocular space, the shape of pronotum, and prominent longitudinal carinae on the mesosternum.

Curicta hungerfordi sp. n.

Size: Male: Length from tip of beak to tip of abdomen 16.5 mm.; length of respiratory appendages 8.2 mm. Females: Length 19.3 mm., respiratory appendages 8.2 mm.

Color: Dark brown, with appendages light brown.

Shape: A small species, rather broadly elongate-oval.

Structural characteristics: Length of head from anterior margin of lora to anterior margin of eyes a little less than length of head from posterior margin of eyes to posterior margin of vertex. Jugae not as prominent as tylus; tylus continued posteriorly as a longitudinal carina to a point just anterior to posterior margin of vertex. Width of head through eyes 1.9 mm.; transverse diameter of eye one-third less than width of interocular space. Anterior width of pronotum 2.6 mm.; posterior width 4 mm.; median longitudinal length 3 mm.; posterior width one and one-half times greater than anterior width and one-third greater than median longitudinal length. Anterior margin of pronotum broadly and roundly emarginate with head inserted in this emargination almost to posterior margin of eyes; posterior margin broadly emarginate. Pronotum having two longitudinal carinae bordering the median longitudinal sulcus and two other less prominent longitudinal carinae which begin immediately behind the middle of the eyes, diverge laterally a short distance, and then run posteriorly to transverse grooves forming a sulcus between each of the lateral carinae. Scutellum triangular with lateral sides rounded; tricarinate with lateral carinae contracted at middle and with median carina running to posterior end of scutellum. Claval suture distinct, membrane prominent and large. Respiratory appendages shorter than length of abdomen and relatively thin and weak. Penultimate segment of antenna with lateral prolongation which is more than half the length of the ultimate segment. Prosternum prominently inflated and swollen on posterior half. Length of anterior coxa subequal to width of head through eyes and having a flattened dorsal side and rounded ventral side. Anterior femur 4.4 mm. in length, slightly greater than the posterior width of pronotum; femoral teeth situated one-third length of femur from the base. Length of femur from base to middle of femoral tooth 1.5 mm.; length of apical portion of femur from middle of tooth to apex 2.9 mm. Anterior tibia when folded against the femur reaches slightly beyond middle of femur. Anterior tarsus reaches to femoral tooth. Mesosternum swollen, metasternum with posterior margin widely rounded with lateral posterior margins, ending in a pointed lobe leaving a large portion of first abdominal segment exposed. Fifth abdominal sternite having two converging carinae which meet on median line at posterior third of sternite and again diverge for rest of segment. Intermediate tibia a little shorter than intermediate femur. Posterior tibia a little longer than posterior femur. Intermediate tarsus a little less than two-

thirds length of posterior tarsus. Male genital operculum broad, spoon-shaped with rounded posterior margin. Connexivum very little developed.

Distribution: Holotype male and allotype female from Real de Arriba, Temascaltepec Dist., Mexico (H. E. Hinton); one female paratype from Morelos, Mexico (H. D. Thomas) and two female paratypes from Pachuca, Mexico (J. C. Shaw). Types in the Snow Entomological Collections.

Notes: This species is shorter and broader than **C. scorpio** Stål. The size of the species, the shape of the pronotum, and the width of the eyes compared to the width of the interocular space, are distinctive.

There is another series of 9 males and 13 females from Talpam D. F., Mexico, July 23, 1937 (H. D. Thomas) which have the same general facies but are relatively smaller. The length of the males from tip of beak to tip of abdomen is 12.4 to 14.3 mm., length of respiratory appendages 7.1 to 8 mm.; females: length 15.4 to 16 mm., length of respiratory appendages 7.1 to 8.4 mm. They are distinguished from **C. hungerfordi** sp. n. by the absence of the median longitudinal carina on the vertex, the width of eyes being slightly less than half the width of the interocular space, by the absence of prominent longitudinal carinae on the vertex, and by the shape of the pronotum which does not have the posterior width of pronotum one and one-half times the width of the anterior pronotum. There is slight variation in the genital claspers between these two forms and they are therefore not considered as a sub-species.

Curicta peruviana sp. n.

Size: Male: Length from tip of beak to tip of abdomen 24.5 mm.; length of respiratory appendages 20 mm.; posterior width of pronotum 4.5 mm. Female: Length 26.5 mm.; length of respiratory appendages 21 mm.; posterior width of pronotum 4.9 mm.

Color: Greyish black, tibiae yellowish-brown with mottled reddish brown.

Shape: A rather sturdy species, elongate oval in form, with prothorax slightly longitudinally arched in lateral view.

Structural Characteristics: Length of head from anterior margin of lora to anterior margin of eyes subequal to length of head from posterior margin of eyes to posterior margin of vertex. Jugae large, closely appressed to tylus, as prominent as tylus. Vertex rounded. Width of head through eyes 2.2 mm.; width of one eye slightly less than half the width of interocular space. Anterior margin of pronotum deeply and angularly emarginate; posterior margin broadly and roundly emarginate. Anterior width of pronotum 3.2 mm.; posterior width 4.5 mm.; median dorsal longitudinal length 4.5 mm. subequal to posterior width. Wide shallow median fossa on anterior half of pronotum which is bordered by indistinct carinae which fade out completely at middle. Two lateral carinae, start at anterior margin of pronotum directly behind eyes, diverge laterally, then run posteriorly fading out just anterior to transverse grooves. Median carina starts posterior to median fossa, divides, branches diverge and run out at transverse grooves. Scutellum a curvilinear triangle, ending posteriorly in an acute angle; median longitudinal length of scutellum slightly greater than width at base;

anterior half plain and posterior half with median carina bordered with lateral depressions. Hemelytra of usual shape with prominent membrane. Dorsal plates comprising last abdominal segment, posterior to hemelytra bearing two lateral longitudinal indistinct carinae which appear to be made up of hairs matted together. Penultimate segment of antenna having a lateral prolongation over half the length of ultimate segment. Length of anterior femur 7.1 mm.; femoral teeth situated one on either side of femoral groove, distinctly closer to base than apex of femur. Length of femur from base to middle of tooth 2.9 mm., of apical portion from middle of tooth to apex 4.2 mm. Femur increases in width anterior to femoral teeth so that greatest width of femur is anterior to femoral teeth. Tibia when folded against the femur extends to middle of femur; anterior tarsus pointed, distinct, and extends beyond anterior margin of femoral teeth. Prosternum typical of **Curicta** with posterior portion inflated; mesosternum inflated. Posterior margin of metasternum broadly and roundly emarginate with lateral sides ending in blunt lobes, leaving a large part of first abdominal segment exposed. Fifth abdominal sternite of male having two lateral, longitudinal carinae coming together on posterior third and then diverging to posterior margin. Genital operculum broad at base, ending in acute angle posteriorly and having the lateral margins raised dorsally; convexivum prominently raised and extending perceptibly beyond end of operculum. Intermediate and posterior tibia each slightly longer than their respective femur. Posterior tarsus 2.9 mm. in length; almost two times as long as intermediate tarsus.

Distribution: Holotype male, allotype female and 19 male and 15 female paratypes all from Vin. Sani Beni, Peru, S. A., October 17 to 25, 1935 (F. Woytkowski) in the Snow Entomological Collections.

Notes: This species is closely related to **C. pronotata** sp. n. but differs in that the posterior width of pronotum is subequal to median longitudinal length, the median fossa is not as distinct, the presence of longitudinal carina and the type of emargination of posterior margin of pronotum; the shape of the scutellum; the membrane of hemelytra much larger, and respiratory appendages distinctly longer.

Curicta pronotata sp. n.

1922. **C. howardii**, Hungerford, H. B., Kans. Univ. Sci. Bull. XIV, No. 18, pp. 430-431.

Size: Male: Length from tip of beak to tip of abdomen 21.5 mm.; length of respiratory appendages 9 mm.; anterior width of prothorax 3.4 mm., posterior width of prothorax 4.55 mm., width of head including eyes 2.4 mm.; greatest width of abdomen 4.9 mm.; dorsal median length of pronotum 4 mm. which is perceptibly less than its posterior width.

Color: Uniform reddish brown.

Shape: A relatively broad and sturdy species with sides of abdomen more elliptical in shape than in most **Curicta.**

Structural Characteristics: Length of head from anterior margin of lora to anterior margin of eyes a little less than length of head from posterior margin of eyes to posterior margin of vertex. Tylus not raised above level

of jugae; jugae swollen, almost parallel and running out posterior to point where tylus stops. Vertex rounded, slightly raised, having indistinct median longitudinal carina. Eyes small, width of an eye equal to half the width of the interocular space. Prothorax somewhat longitudinally arched in lateral view. Anterior margin of pronotum widely and deeply emarginate, emargination angular, slightly greater than a right angle; posterior margin widely and broadly emarginate. Anterior width of pronotum less than, and posterior width greater than, dorsal median length. Median longitudinal portion of pronotum raised with a median longitudinal fossa confined to the anterior part. Lateral sulci on middle broaden out into shallow grooves ending behind the eyes anteriorly and terminating in the transverse grooves posteriorly. Lateral margins of pronotum parallel on middle third, widening to form a rounded lobe anteriorly, and broadening out prominently on posterior third. Scutellum triangular with the anterior disc having two parallel longitudinal carinae, while the posterior half has a more prominent median longitudinal carina with declivities on the sides which extend to the lateral margins of scutellum. Median longitudinal length of scutellum subequal to width at base. Longitudinal carina with very reduced median lobes on the terga covering the last abdominal segment posterior to the hemelytra. Antenna reduced, penultimate segment with a short lateral prolongation.

Anterior femur stout, long, one-fourth longer than lateral length of pronotum. Femoral teeth are not at the middle, being located almost two-fifths of the length of the femur from the base. Anterior tibia when folded back against the femur extends to the middle of the femur; tarsus tapered and reaching to middle of femoral teeth. Anterior coxa prismatic and stout, two-thirds the median dorsal length of pronotum. Prosternum having two faint grooves originating behind anterior coxae, running posteriorly, and meeting mesally just anterior to posterior margin of prosternum. Meso- and metasterna produced, mesosternum slightly wider than metasternum. Posterior margin of metasternum broadly and roundly emarginate, lateral angles produced as teeth, leaving large portion of the first abdominal segment exposed. Median length of sternite of fifth abdominal segment greater than that of any of the other abdominal segments, having two carinae separated at anterior margin which come together at middle and again diverge to posterior margin. Male genital operculum long and broad with rounded posterior margin. Intermediate femur about four-fifths the length of posterior femur and tibiae slightly shorter than their respective femora.

Distribution: Holotype male and one male paratype from Huachuca Mts., Arizona 1899, in the collection of H. G. Barber. Also one male paratype with sama data in the Snow Entomological Collections.

Notes: This species is closely related to **C. peruviana** sp. n. They can be readily distinguished from each other by the length of the respiratory appendages.

One specimen bears a label **C. howardi** Mont., compared with type, Det. Drake, 1918. This is an error. Since these specimens did not fit Doctor

Montandon's description of **C. howardi** Mont. they were forwarded to the United States National Museum where Doctor R. I. Sailer confirmed this determination. Due to this error Doctor H. B. Hungerford redescribed **C. howardii** Mont. for his new **C. drakei** Hung.

NEW MATERIALS TESTED AND USED FOR PINNING BOARDS[1]

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The new materials used for the board for pinning insect specimens are ordinarily Balsa wood and compressed cork. However, in China, both are too expensive, in spite of their fitness and usefulness for the purpose. As a matter of fact, there are also many difficulties of transportation and currency exchange nowadays in importing these materials. New materials need to be tested and used instead.

A good material for the board for pinning insect specimens is believed to have the following requirements:

1. Soft enough for insect pins.
2. No acid or alkaloid effect on the insect pins, in order to avoid rusting.
3. Durability.
4. Inexpensive and easily obtainable.

The materials which we have tested and used are described below:

Chinese Grass mat.—Its vernacular name is Hsi, made from a kind of grass, **Juncus effusus** L., and widely used on beds as an upper part of the mattress in summer time. Its acidity has been tested as pH 7 or just neutral. It is as soft as the American made compressed cork. The present price is only about ten U.S. cents for a square foot. Furthermore, it has been used in our specimen boxes for more than ten years and has proved satisfactory.

Rushes.—This material is used in China for bags. The species has been identified as **Typha latifolia** L. Its acidity has also been tested as pH 7 or neutral. It is a little softer than the American compressed cork and costs about five U. S. cents for a square foot. However, one needs three layers for each insect specimen box owing to the fact that its thickness is only about 3 mm.

The pith of Kaoling is also a good material for the board for pinning insect specimens. It has been used in our laboratory about fifteen years. It is not as durable as other boards used in our insect boxes and is now almost decomposed and almost incapable of holding insect pins any more.

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[1] Contribution from the Institute of Zoology, National Academy of Peiping, Ser. C. No. 13.

FOOD-PLANTS, DISTRIBUTION, AND ABUNDANCE OF THE BIG-HEADED GRASSHOPPER, AULOCARA ELLIOTTI (THOS.)

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The big-headed grasshopper, **Aulocara elliotti** (Thos.), is a grassland species occurring throughout the Grassland Biome of North America. Carpenter (1940) recognizes only three associations in this biome: the tall-grass prairie, the mixed-grass prairie, and the short-grass plains. **Aulocara elliotti** has been found in all of these associations except in the eastern part of the tall-grass prairie. The Grassland Biome as described by Clements and Shelford (1939) is more inclusive and embraces the following associations: true prairie, mixed prairie, desert plains, coastal prairie, California prairie, and palouse prairie. **Aulocara elliotti** has been taken in all of these associations. It has also been found in the Northern Desert Shrub Biome and in montane forest areas. No doubt, its subsistence is possible in these regions as a consequence of the presence of grasses.

Food-plants

The food-plants of **Aulocara elliotti** are found among members of the grass family. Observations made by Criddle (1933) showed that in Canada it fed on several species of grasses. In Wyoming it has also been found feeding on several kinds of grasses. Detailed observations of the feeding habits were made in an area on the short-grass plains of eastern Wyoming where the species was particularly abundant. The dominant plants in this area were western wheat grass (**Agropyron smithii** Rydb.), Sandberg bluegrass (**Poa secunda** Presl.), and dandelion (**Taraxacum erythrospermum** Andrz.). There were several other grasses and forbs present but in much less density. It was found that first and second instars fed chiefly on Sandberg bluegrass, but that older instars and adults fed almost entirely on western wheat grass. The change in diet seemed to parallel a seasonal change in the condition and abundance of these two grasses. Both grasses are equally available early in the season, but later on Sandberg bluegrass becomes reduced in volume and usually dries out, whereas western wheat grass increases in volume and remains green. The change in food-plants appeared to be a result of this seasonal change, although it is possible that the older instars and adults may have actually preferred western wheat grass above Sandberg bluegrass. The feeding of the younger instars indicated that they preferred bluegrass above western wheat grass.

Food preference tests have been made which show that **Aulocara elliotti** prefers grasses above forbs. It was also found that among the grasses some species are preferred above others. The details of these tests as well as studies on the rearing of **Aulocara elliotti** upon several food-plants will be reported in a subsequent paper.

Distribution

The distribution of **Aulocara elliotti** is shown in Figure 1. This map was prepared mainly by compiling published records and by obtaining unpub-

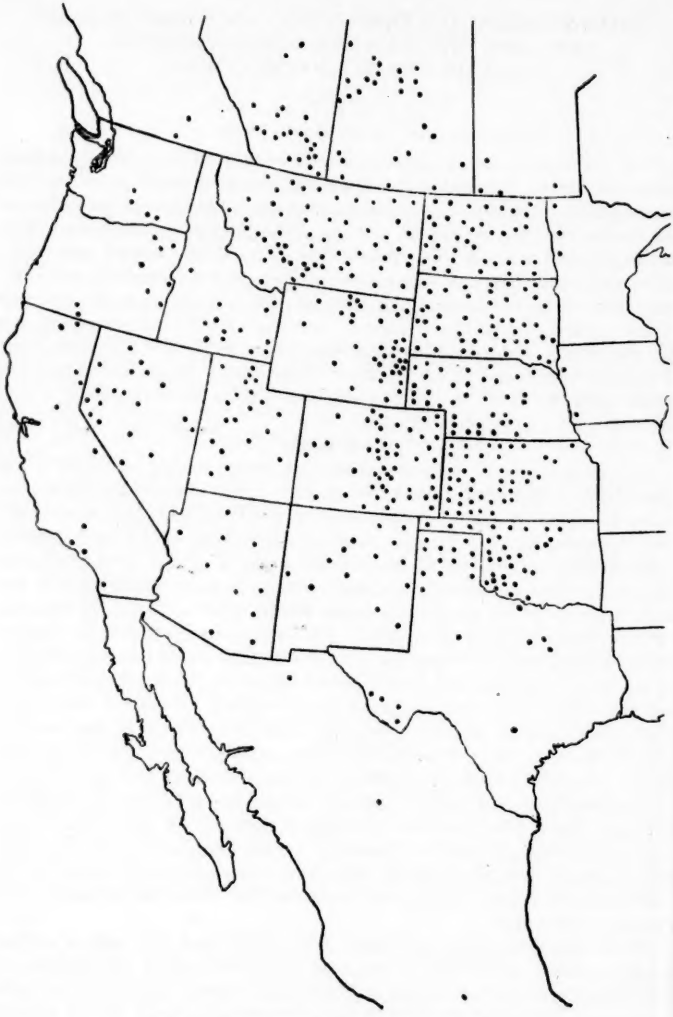

Fig. 1. Distribution of **Aulocara elliotti.**

lished records through correspondence. Most of the Wyoming records, however, were taken by the writer. Northern limits of the species are Vernon, British Columbia (Hebard 1928); Lavoy, Alberta (White and Rock 1945); Marshall and Aylsham, Saskatchewan (personal communication, H. W. Moore 1946); and Miniota, Manitoba (personal communication, R. H. Handford 1946). **Aulocara elliotti** has thus been taken at northern limits of the Grassland Biome. Eastern limits are Arnaud, Manitoba (Bird 1937); Kittson, Polk, and Clay counties, Minnesota; Plymouth and Mills counties, Iowa; and Brown County, Kansas (survey records of the Bureau of Entomology and Plant Quarantine); Osage and (or) Payne counties, Oklahoma (Bragg 1939); and Ellis County, Texas (Isely 1935). All of these eastern records are deep in the tall-grass prairie. The species, however, is not as abundant in the tall-grass prairie as it is on the short-grass plains. According to the observations of Bruner (1897) it is common in central and western Nebraska but is rather rare in the eastern part. Whelan (1938) in studying the Orthoptera of a tall-grass prairie tract nine miles northwest of Lincoln, Nebraska did not find any **Aulocara elliotti.** In the report of the 1935 grasshopper survey, Shotwell (1936) records the capture of nineteen specimens in western but none in eastern Nebraska. Between 1937 and 1941 over one and one-half times as many **Aulocara elliotti** were found in the western as in the eastern part of the state (Shotwell and Skoog 1942). There is a similar distribution of **Aulocara elliotti** in North Dakota. In the 1935 grasshopper survey ninety-five specimens were captured in western but none in eastern North Dakota and between 1938 and 1941 almost three times as many **Aulocara elliotti** were found in the western as in the eastern part of the state. The species is rare in Iowa and in Minnesota having been taken from only three counties in the extreme west in Minnesota and from only two counties in the extreme west in Iowa. **Aulocara elliotti** has been found to be an important species on the range in Kansas (Shotwell 1938b). However, at Manhattan which is in the eastern part of the state and therefore in the tall-grass prairie, Wilbur and Fritz (1940) collected only two specimens in a study made from 1933 through 1939. Woodruff (1937) collected no **Aulocara elliotti** during a grasshopper survey of eastern Kansas in 1936.

The distribution of **Aulocara elliotti** reaches far south through the desert plains grassland of Arizona, New Mexico, Texas, and Mexico. Hebard (1932) records one female from as far south as Cuernavaca, Morelos. Western limital records are Yakima and Ellensburg, Washington (Bruner 1885); Klamath Lake, Oregon (Caudell 1908); Merrill, Oregon (Fulton 1930); Tehachapi, California (Scudder 1899); Los Angeles and San Diego, California (Bruner 1905b); and Roseville, San Luis Obispo, and Santa Paula, California (personal communication, C. C. Wilson 1946).

Abundance

Aulocara elliotti has at times become very abundant in many parts of its range. Populations of out-break proportions have been reported most frequently from the short-grass plains, but high populations have also been recorded in Washington, New Mexico, Arizona, and Utah. The clearest

accounts of outbreaks of **Aulocara elliotti** appear in the reports of the State Entomologist of Montana. Cooley (1904) reported heavy range infestations of grasshoppers in eastern Montana during 1901, 1902, and 1903. The three most common grasshoppers in increasing order of abundance were **Camnula pellucida, Melanoplus mexicanus,** and **Aulocara elliotti.** So completely were the grasses of the range destroyed in some parts of Montana that ranchers were obliged to sell their stock or to move them to distant ranges. Cooley stated that the trouble began in two localities 150 miles apart, one in Carbon County and the other in Rosebud County. In these localities the insects steadily increased for three years until in 1903 the advancing border lines met in the vicinity of Billings. Other areas of the short-grass plains were also heavily infested at this time, for Bruner (1902) reported large numbers of grasshoppers in western Nebraska, western Kansas, eastern Wyoming, and eastern Colorado during 1901. One of the prevailing species was **Aulocara elliotti.** Bruner noted grasshoppers to be bad at Casper, Wyoming, but not so bad as farther east in Wyoming and some portions of Nebraska. Bruner (1905a) found that the outbreak had ended in 1904. Swenk (1913) reported an outbreak of range grasshoppers in western Nebraska during 1910 to 1912. **Aulocara elliotti** was one of the species represented in this outbreak.

Grasshopper outbreaks again occurred on the ranges of Montana from 1919 to 1923. Cooley (1919) reported large numbers of **Aulocara elliotti** in three south-western counties of Montana: Gallatin, Beaverhead, and Madison. At about the same time, that is, in 1921 and 1922, Corkins (1923) reported serious infestations of pasture lands in Colorado. A survey of species infesting the foothills of Larimer County showed that **Melanoplus mexicanus, Ageneotettix deorum,** and **Aulocara elliotti** were the most abundant species.

From 1934 to 1937 the short-grass plains of Montana were once again heavily infested with grasshoppers and according to Strand (1937) the most important species were **Aulocara elliotti** and **Melanoplus mexicanus.** During the same years the short-grass plains of Wyoming, Colorado, Nebraska, North Dakota and South Dakota were similarly infested. The important species involved in the outbreak were **Aulocara elliotti, Melanoplus mexicanus,** and **Ageneottix deorum** (series of papers by Shotwell 1934 to 1938 and Morton 1939).

White and Rock (1945) report that **Aulocara elliotti** is economically the most important species of the grasshoppers affecting the short-grass plains in Alberta.

All of the above records of heavy infestations are restricted to the short-grass plains, but populations of outbreak proportions outside of this area have been recorded by several observers. Bruner (1885) reported **Aulocara elliotti** numerous at Yakima, Ellensburg, and many other points in eastern Washington in 1882. In 1885 the same author found much grasshopper damage of grasses in the Northwest and noted that **Aulocara elliotti** was a very common species. Hatch (1938) regards **Aulocara elliotti** as being an injurious pest in Washington. A heavy infestation of the rangeland in Catron and Socorro counties, New Mexico, in 1892, was reported by Townsend (1893).

The principal species was **Aulocara elliotti.** The infestation extended into Apache County, Arizona. At Pratt's ranch in southeast Apache County, Townsend was told that these grasshoppers had destroyed the garden and field crops there the previous year, 1891, and had eaten up the grain field for three consecutive years, 1889 to 1891. Townsend reported that the abundance of grasshoppers on the date of his observance, June 22 and 23, 1892, indicated destruction of the crop for the fourth consecutive time. Ball et al. (1942) state that **Aulocara elliotti** is one of the most injurious range grasshoppers in Arizona, especially in Graham County and on the Mongollon Plateau. Henderson (1931) has reported that the species is an enemy to agriculture in Utah. He notes that it is numerous and widely distributed in dryland sections of the state and is at times destructive to cereals and alfalfa crops as well as to range grasses. The results of the present study, however, indicate that alfalfa is not fed upon by this grasshopper. Knowlton and Jones (1932) report that **Aulocara elliotti** was especially destructive to wheat in Utah in 1931.

Summary and Conclusions

The big-headed grasshopper, **Aulocara elliotti** (Thos.), is a grassland species. Both observational and experimental data indicate that grasses are necessary as food-plants. The species occurs in all of the associations of the Grassland Biome of North America; however, the largest populations are found in the more arid associations such as the short-grass plains, the desert plains, and the palouse prairie. Large numbers have also occurred in parts of the Northern Desert Shrub Biome. The subsistence of the species in these areas is no doubt dependent upon the presence of grasses. The scarcity of grasses in the more arid shrub communities of Western North America is probably a limiting factor in its distribution. Only small populations occur in the tall-grass prairie. The low numbers can not be explained on the basis of lack of food-plants. Possibly the limiting factors in this association are the conditions of increased moisture and denser vegetation.

Acknowledgments

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THREE NEW SPECIES OF MALLOPHAGA

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Oxylipeurus montezumae n. sp.

(Figures 1-2)

Male. Head circumfasciate, long and narrow; widest at the antennal region. Trabeculae small, barely projecting beyond lateral margins of head. First antennal segments enlarged but without appendages; third segments produced beyond points of articulation with the fourth. Prothorax with a small dorsal seta in each posterolateral angle. Pterothorax twice as long as prothorax, widest at posterior margin, with two pairs of long setae in each dorsal posterolateral angle. Abdominal segments each armed dorsally with two median setae, and with one or more setae in each posterolateral angle. Ventrally, on last segment, a pair of patches of setae; each patch having two rows of medium-length setae, a posterior row with four setae, and one anterior row with three. Dorsal and ventral chaetotaxy as shown in figure 1. Genitalia with curved tapering parameres as shown in figure 2.

Type host. Cyrtonyx montezumae mearnsi Nelson, Mearns's Quail.

Type material. Holotype male, and one immature specimen collected by Dr. A. R. Phillips on the Apache Indian Reservation, Arizona.

Discussion. The male genitalia easily distinguish this form from all other known species. The long curved tapering parameres are distinctive. The odd-shaped endomeral plate and the small penis (figure 2) are very unusual. It is believed that future collections of Mallophaga from the Odontophorinae may yield many interesting forms.

Lagopoecus gambelii n. sp.

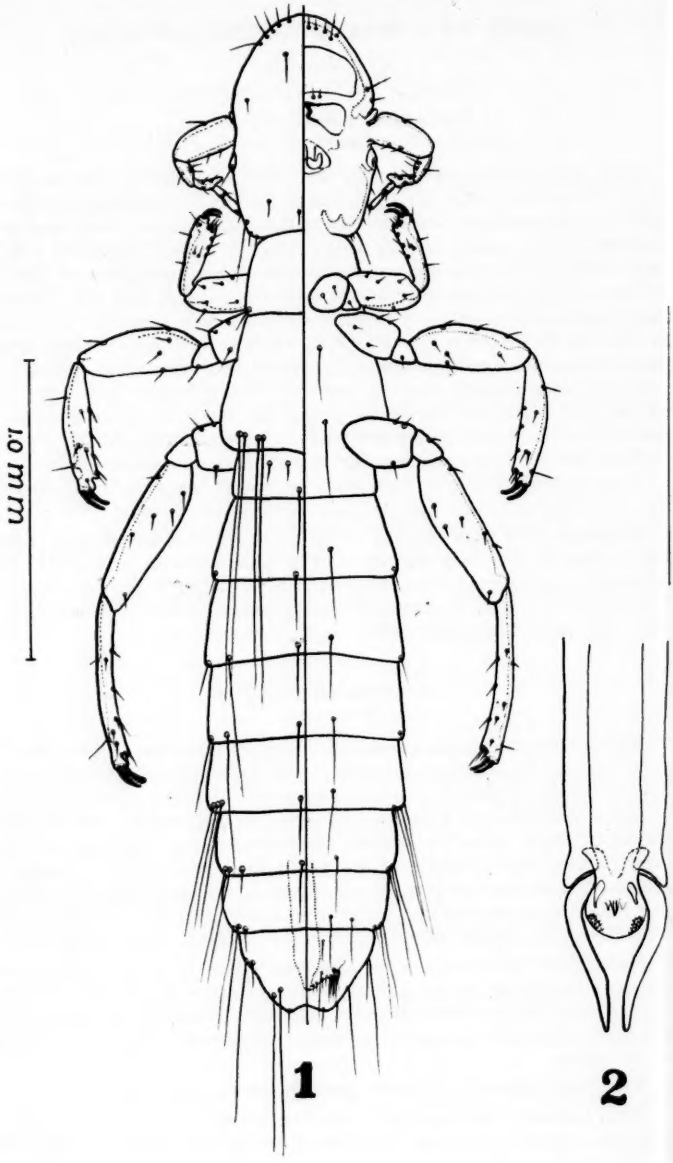
(Figures 3-5)

Female. Clypeal margin pointed, and with scattered small setae. Trabeculae well developed. Antennae filiform, the second segments being longest. Eye prominent, with a long seta arising from the dorsal surface. Temples convexly rounded, each with two long setae; cephalic margin without setae. Prothorax short, wide, and armed dorsally with one long seta on each posterolateral angle. Pterothorax twice as wide as long, widest at posterior margin. Dorsal posterior pterothoracic setae as shown in figure 3. Abdominal tergal plates prominent, separated medianly; each with a row of setae on posterior margin. Dorsal and ventral chaetotaxy as shown in figure 3.

Male. Head approximately the same size as in the female. Thorax and abdomen essentially the same shape, as in the female, but smaller. Chaetotaxy, except for posterior abdominal segments, essentially the same as in the female. Genitalia as shown in figure 5. Parameres unusual, not typical of the genus.

Type host. Lophortyx gambelii gambelii Gambel, Gambel's Quail.

Type material. Holotype male, allotype female, collected by Dr. A. R. Phillips at Tucson, Arizona. Paratypes from the same collection and from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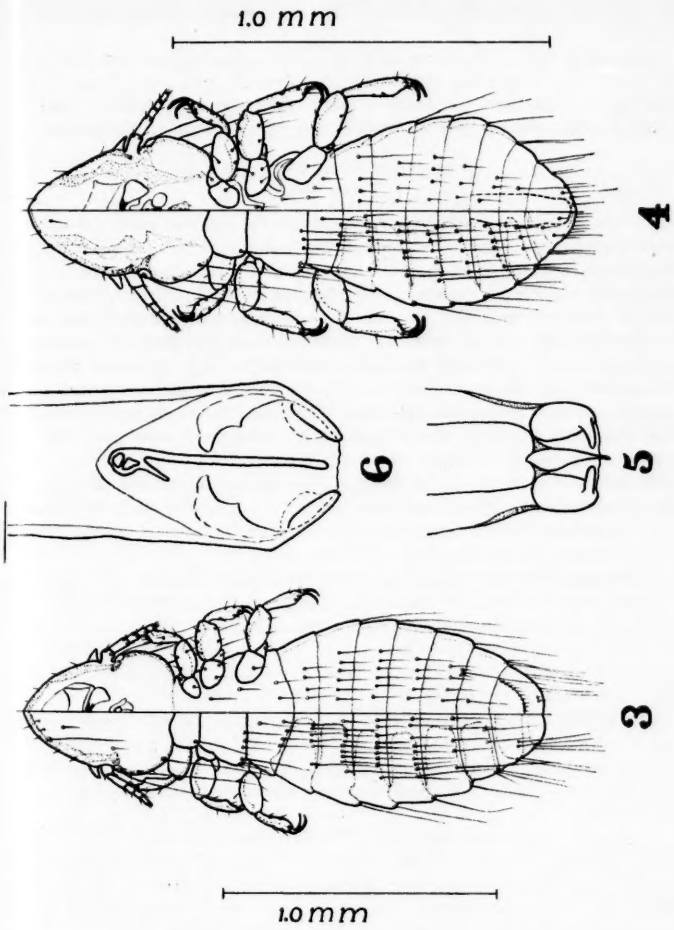

Explanation of figures.

1. **Oxylipeurus montezumae** n. sp., dorsal-ventral view of the male.
2. **Oxylipeurus montezumae** n. sp., male genitalia.
3. **Lagopoecus gambelii** n. sp., dorsal-ventral view of the female.
4. **Lagopoecus gambelii** n. sp., dorsal-ventral view of the male.
5. **Lagopoecus gambelii** n. sp., male genitalia.
6. **Lagopoecus colchicus** n. sp., male genitalia.

the type host collected on the Santa Rita Reservation, Arizona by Dr. Glen M. Kohls.

Discussion. The author has seen no species that particularly resembles this form. The parameres (figure 5) are very different from those of any other known species. This form is easily recognized by the fact that the clypeal margin is more pointed than in any other species of the genus.

Lagopoecus colchicus n. sp.
(Figure 6)

Female. Clypeal margin evenly rounded, with scattered small setae. Head shorter and wider than in **L. obscurus** Emerson. Eyes prominent, each with one long seta. Temples rounded, each with two long setae and three short setae; cephalic margin without setae. Prothorax short, narrow, and armed dorsally with one long seta on each posterolateral angle. Pterothorax twice as wide as long; dorsal posterior chaetotaxy of 2,2,2, and 2. Abdominal segments with brown areas on lateral margins as in **L. obscurus** Emerson. Abdominal tergal plates each with eight median setae and one post-spiracular seta on each posterolateral angle. Pleural plates of segments three and four, each with one long seta; of segments five to eight, each with two long setae. Sternal plates with two median setae.

Male. Head approximately the same size as in the female. Thorax and abdomen essentially the same shape, as in the female, but smaller. Chaetotaxy, except for the posterior abdominal segments, same as in the female. Genitalia as shown in figure 6.

Type host. Phasianus colchicus torquatus Gmelin, Ring-necked Pheasant.

Type material. Holotype male and allotype female, collected by Mr. Paul E. Telford, in Logan, Utah. Paratypes from the same collection and from the type host collected as follows:

Homer, Illinois, Dr. Yeager; Urbana, Illinois, Dr. H. H. Ross; Hamilton and Lake County, Montana, Dr. William L. Jellison.

Discussion: This form is related to **L. lyrurus** Clay, **L. gibsoni** Hopkins and **L. obscurus** Emerson. The new form is wider and more robust than those mentioned. The pterothoracic and abdominal chaetotaxy easily separate this form from the other known species. The male genitalia is also distinctive.

In view of the extensive studies which have been made of the Ring-necked Pheasant, it seems highly improbable that any of its parasites should be new. Since this form has been collected by four workers in five different localities; it is believed that there can be no explanation except that it has been overlooked until now.

Acknowledgments

The author gratefully acknowledges that the material used in this study was furnished by Dr. William L. Jellison of the Rocky Mountain Laboratory, Hamilton, Montana; Dr. H. H. Ross of the Illinois Natural History Survey, Urbana, Illinois; Mr. Paul E. Telford of Ohio State University, Columbus, Ohio; and Drs. A. R. Phillips and Charles T. Vorhies of the University of Arizona, Tucson, Arizona.

DIFFERENTIAL STAINS FOR INSECT EXOSKELETON

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All too frequently, technicians need a means of identifying chitin and chitinoid materials quickly and with certainty. Such a process is described here.

Giemsa stain (Azure II—eosin), in almost any reasonable dilution, stains chitinoid materials of insect exoskeleton and egg capsules a very contrasting light green, while associated tissues are stained blue or red.

No special preparations of materials are necessary for use of this stain. Good staining has been obtained in sections following fixation in all standard fixatives except those containing osmic acid, as well as in fragments resulting from grinding, maceration in water or KOH, or drying.

The stain is made up in stock solution by dissolving 1 gm. of the powdered stain in 66 cc. of reagent glycerine at 60°C for 24 hrs., then adding 66 cc. of acetone-free methyl alcohol. A similar stock solution can be obtained from supply houses as either "Giemsa Bood Stain" or as "Azure II—eosin". For use, 1 cc. of the stock solution is mixed with 50 cc. distilled water, and 0.5 cc. of a .1% $NaHCO_3$ solution added to make the mixture very slightly alkaline. Tap water with pH 7 to 8 is satisfactory instead of distilled water and $NaHCO_3$. If an intense stain is desired, a few drops of methyl alcohol will aid penetration and delay precipitation of the stain.

For staining sections on slides, the following procedure is used:

1. Wash the slide in water to remove acids, acetone or alcohol.
2. Immerse the slide in the stain for 30 to 90 min., depending on intensity desired. If impurities cause an early precipitation of the stain, replace with a fresh stain solution.
3. Rinse in water.
4. Differentiate in acetone until desired contrast is obtained. Usually 30 seconds is sufficient. Ethyl or methyl alcohol may be used instead of acetone, with longer time and generally with less clear-cut differentiation.
5. Either dry the slide quickly by waving it in the air, or dip it in xylol to stop destaining action.
6. Cover with oil for temporary slides, or put on a mounting medium and cover with glass for permanent preparations.

A properly differentiated preparation will show chitinoid materials light green, nuclei blue to black and cytoplasm pink to red. Understaining results in a mustard-green, overstaining gives a blue-green. Chitinous layers hold the green tenaciously once the stain has penetrated. The blue color may be completely removed from tissue with acetone before the green in the chitin is seriously affected.

This stain has proven to be very useful in detecting early formation of exoskeletal material of a chitinous nature, the chitinous lining of the fore and hind guts of insect embryos, and the chitin-like egg cases.

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[1] Contribution No. 263 from the Department of Zoology, Kansas State College. Most of the work leading to this report was done at Indiana University and at Harvard University during studies on the embryology of cockroaches.

Insect fragments in aqueous suspension may be stained merely by adding stain to the suspension at the rate of one drop of stock solution of stain per cubic centimeter of suspension. Staining time is approximately one hour at room temperature. Less time does not allow for penetration, too much time results in an overstaining of the chitin with loss of differentiation, and greater concentration of stain results in precipitation. Staining time may be reduced to thirty minutes by maintaining the stain solution at 40°C.

The greatest drawback in the use of this stain is its sensitivity to acidity. Satisfactory staining can be expected only in near-neutral to slightly alkaline solutions (at pH 6.5 to 9.0). This can normally be determined as the turning point of litmus to blue, or it may be approximated by adding a few drops of .1% solution of $NaHCO_3$ to distilled water. If specific tissue differentiation is desired, special care must be given to stain concentration, time, and pH, as described in standard technic books.

The green coloration of chitin by Giemsa stain is due to the action of a fraction of Azure. If the tissue differentiation given by Giemsa is not desired, Azure I (Azure A) as a 1% solution in methyl alcohol may be substituted for the stock solution of Giemsa. The resulting stain differentiates chitinoid material as pale green and other materials as blue-green to intense blue. Azure I is not so sensitive to hydrogen ion concentration as is Giemsa, and is not subject to precipitation from solution, so may be superior to Giemsa's stain where chitin detection is paramount.

The use of Azure I or secondary derivatives of Azure I as a differential stain for chitin and chitin-like materials must depend on a specific attraction of these materials for the green fraction of Azure. In rather wide use of Giemsa's stain and Azure I in insect embryology and histology and in detection of insect fragments, no material other than these chitinoid materials have been observed to stain green, and these materials take only the green.

Neither Giemsa's stain nor Azure I can be used satisfactorily in permanent preparations, as the blue color fades rapidly in light. In some instances, roach embryos stained with Giemsa and kept in an open tray have lost most of their color in a few months. Even in closed boxes, this stain fades seriously in two or three years.

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